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Research paper

Load Balancing Algorithm for Supply Chain of Processed Oil Distribution

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Abstract

This study focuses on downstream stage that comprises of oil refinery and distribution. The distribution of oil via supply chain is developed using load balancing method to determine how much oil is needed to distribute to factory and gas station in a particular area. This method will not only ensure the stability of the petroleum products distribution system to meet the customer demand but also considers other factors such as population in that particular area. Current practice is where the distribution of processed oil is based on customer order. Hence, customers refer to the factories and gas stations. The distribution issues arise when there's a delay to the processed oil delivery and also uncontrollable of supply chain. This scenario results in not meeting customer order due to imbalance of processed oil distribution because of uncontrolled distribution order. Therefore, this paper proposes a load balancing algorithm to be applied in supply chain of processed oil distribution. The objective is to supply processed oil to the customers according to the right distribution order. As a result, processed oil distribution can be managed in a more systematic way to meet the demand of the end customers and local business.

Keywords: *petroleum; supply chain; crude oil; processed oil distribution; load balancing.*

1. Introduction

The supply chain for processed oil distribution system is designed to ensure stability of the processed oil distribution in order to meet customer demand and also consider other factors such as population in that particular area. Now, in petroleum industry, most of the processed oil distribution is based on order from customers only. It does not consider other factors. Sometimes, it might be inaccurate order from customers. This will cause lack of product can be produced or used by customer and end users. There is a crucial need to improve the way of processed oil distribution in Petronas oil industry.

In a petroleum value chain, there are three stages which are upstream, midstream and downstream. Downstream stage mainly comprises oil refinery and distribution. Through refinery process, the crude oil will be processed into more useful products such as petroleum naphtha, gasoline, diesel, fuel, asphalt base, heating oil, kerosene and liquefied petroleum gas. The products are known as processed oil. The processed oil is then delivered to the headquarters (HQ) for the distribution process. In HQ, there are two ways to distribute the processed oil to the customers which are either distribution to the local business such as factory or distribution to the gas stations. The local business used this processed oil to produce other products such as PVC, polyvinylchloride, nylon, polyester, polystyrene, polypropylene.

The gas stations on the other hand will sell petrol or diesel which is part of the processed oil to the local customers to fill in their vehicles oil tank.

In this paper, we follow supply chain concept as a guideline for distribution processed oil to the customer. Supply chain is a system of organizations, people, activities, information and resources involves in moving a product or service from supplier to customer. In the 1980's, the term supply chain management (SCM) was developed to express the need to integrate the key business processes, from end user through original suppliers. Original suppliers are those that provide products, services and information that add value for the customers and other stakeholders. The primary objective of SCM is to fulfil customer demands through the most efficient use of resources, including distribution capacity, inventory and labour. Therefore, this project follows supply chain concept in order to provide the right distribution processed oil to the customers. Below shown a sample figure of supply chain in petroleum industry that explain how supply chain represents the steps it takes to get the product or service to the customer that can be applied in this project.

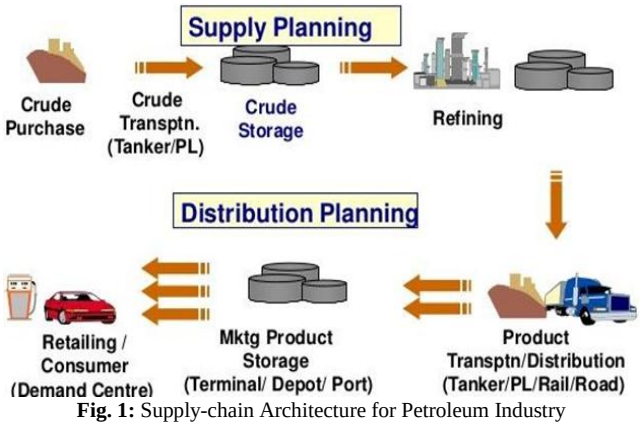


Fig. 1: Supply-chain Architecture for Petroleum Industry

The processed oil is distributed based on customer's demand and order. When there are orders from the customers, the processed oil will be distributed from the oil depot. However, the delivery may be subject to delays which could disrupt the processed oil inventory

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turnover of the customers. In addition, improper processed oil inventory order planned may result insufficient quantity being delivered to certain gas stations for instance, while some may end up with excessive amount of processed oil which may incur additional cost for storage. Therefore, processed oil distribution system needs to consider many factors such as supply and demand factor as well as geographical and demographical factors of the area.

2. Related Works

The research that focus on how to distribute the refined oil from oil depot to meet the needs of each gas station so as to minimize the total cost [1] using ant colony algorithm.
Research in [2] focuses on a strategy to redesign the supply chain, the production process or the product to either reduce the uncertainty the firm faces or hedge uncertainty so that the firm is in a better position to mitigate the consequence of uncertainty. In this research has been used risk pooling strategy and centralizing the inventory at distribution centers as one of the effective ways to manage such a demand uncertainty for achieving appropriate service levels to customer. Genetic algorithm is applied in this research for solving optimization problem. Research by [3] to balance distribution of the key address space to nodes, which yields a load-balanced system when DHT maps items "randomly" into the address space. The second aim to directly balance the distribution of items among the nodes.
The crude oil prices are another contributing factor for demand and order process [4]. Demand from customer is proportionally subjected to the lowest price or cost offer at that particular time of order. The short run of crude oil and surplus capacity is considered in [5]. The heuristic searching algorithm is proposed for loads balancing in an unbalanced electrical distribution network [6]. All of their test cases show high performance in loads balancing and reduced the imbalance index. The work by [7] proposes a mixed integer linear programming (MILP) to determine the optimal configuration of a production and distribution network. The proposed MILP in [7] assist senior operations management in deciding production allocation, production capacity per site, purchase of raw materials and network configuration in chemicals manufacturer.

3. Load Balancing Theoretical Background

Following is the load balancing notation used in [3]. Let n be the number of population in particular areas, N is the quantity of processed oil stored in system (usually N >> n) and ℓi is the number of customer stored at node i. Then the average (desired) quantity of processed oil per person is given by

$$L = N / n$$

If there is higher population in that area, there will be a large amount of processed oil to be distributed to the area compared to area with small population. The statements are applied and adapted to this system as follows:

i. For petrol stations, there must be a number of population in that particular area
ii. For industry, there must be a demand from the customer to supplier
iii. As for the workload concerns, it will be replaced by the number of population
iv. As for the free/active server concerns, it will be replaced by the demand of processed oil from customers

4. Experimentation

In this chapter explains about implementation of load balancing algorithm in Supply Chain for Distribution Processed Oil System and its module. This system involves four user modules; Manager, Tank Surveyor, Operations Executive and Staff. Operation Executive is accountable for load balancing management.

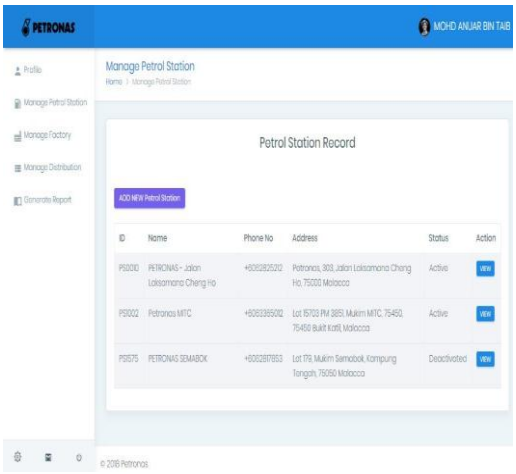


Fig. 2: Manage Petrol Station (Operations Executive)

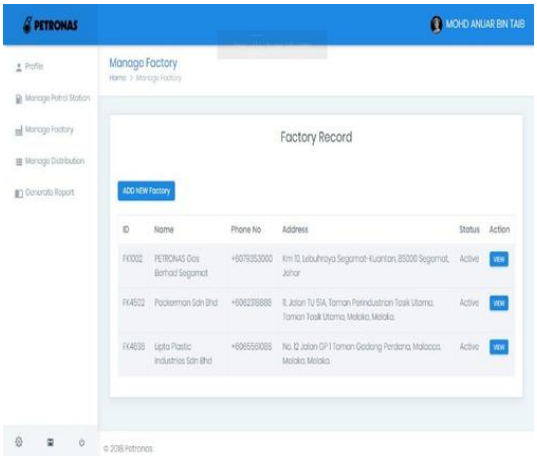


Fig. 3: Manage Factory (Operations Executive)

Below is a sample calculation coding for distributed processing is depicted as in Figure 4.

```
<?PHP          session_start(); ?>
<?php
include ("connection.php");
if ($conn !== FALSE){
    $id=$_GET['id'];

    $TableName = "petrolstation";
    $SQLstring ="SELECT * FROM $TableName WHERE id = '$id'";
    $QueryResult=@mysql_query($SQLstring);
    $num= mysql_num_rows($QueryResult);

    $i=0;
    while ($i<$num) {

        $name = mysql_result($QueryResult, $i, "name");
        $phoneNo = mysql_result($QueryResult, $i, "phoneNo");
        $address=mysql_result($QueryResult, $i, "address");
        $machinePump=mysql_result($QueryResult, $i, "machinePump");

    $TableName2 = "processedoil";
    $SQLstring2 ="SELECT * FROM $TableName2 WHERE type = 'Fuel Oils'";
    $QueryResult2=@mysql_query($SQLstring2);
    $num2= mysql_num_rows($QueryResult2);

    $y=0;
    while ($y<$num2) {

        $seriesNo = mysql_result($QueryResult2, $y, "seriesNo");
        $type = mysql_result($QueryResult2, $y, "type");
        $totalQuantity =mysql_result($QueryResult2, $y, "totalQuantity");
        $price =mysql_result($QueryResult2, $y, "price");
        $thresHold =mysql_result($QueryResult2, $y, "thresHold");

    $TableName5 = "processedoil";
    $SQLstring5 ="SELECT * FROM $TableName5 WHERE type = 'Diesel Fuel'";
    $QueryResult5=@mysql_query($SQLstring5);
    $num5= mysql_num_rows($QueryResult5);
```

Fig. 4: Distribution Coding for petrol station

The sample of report that is generated by the system is as in Figure 5 and 6.

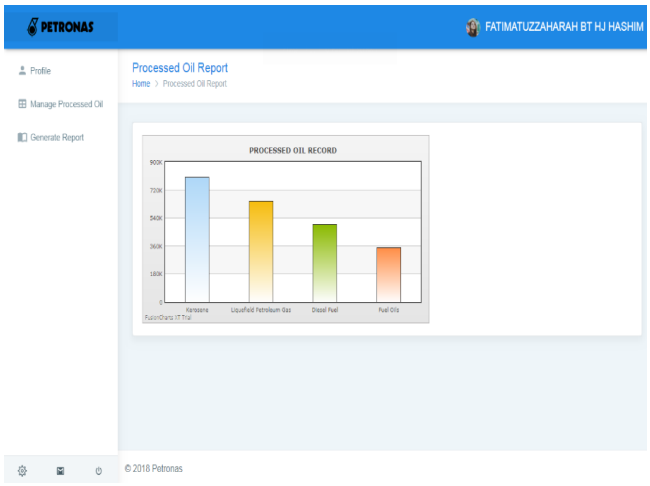


Fig. 5: Processed Oil Report of Tank Surveyor (in graph)

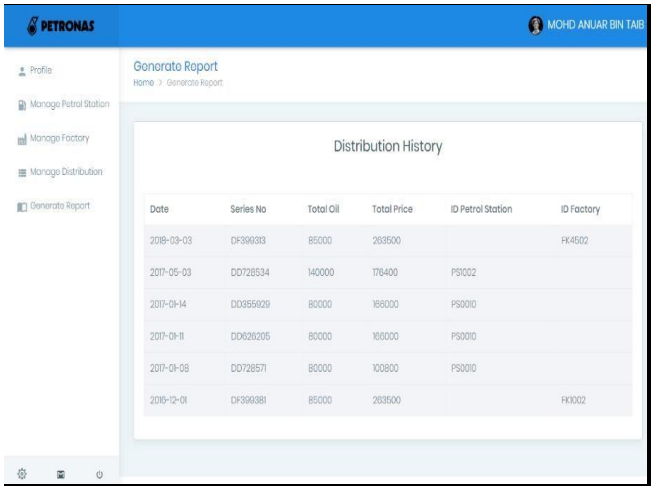


Fig. 6: Distribution report (in Table)

5. Conclusion

In conclusion, this project focused on implementing the supply chain concept with load balancing algorithm to distribute the processed oil to the customers. This method proves that the distribution process has met the requirements and objectives of this system and able to solve all the problems mentioned.

Acknowledgement

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